COPPER RIVER HYDROACOUSTIC SALMON ENUMERATION STUDIES, 1999

by

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ABSTRACT

The Miles Lake hydroacoustic project was initiated in 1978 to estimate annual salmon escapement into the Copper River. Studies conducted during 1999 used Bendix Corporation single beam side-scanning sonar equipment deployed on the north and south banks of the Copper River near the outlet of Miles Lake, approximately 53 km upriver from the commercial fishing district. In 1999, salmon escapement past the sonar site was estimated to be 850,951 during the time period from May 23 through August 3. Although it has not been possible to collect information at the site on species composition, most of the salmon passing the site are assumed to be sockeye salmon *Oncorhynchus nerka.* This species comprises more than 90 percent of the salmon harvest in Copper River commercial, recreational, subsistence and personal use fisheries.

KEY WORDS: Copper River, hydroacoustics, migration, Miles Lake, *Oncorhynchus nerka*, Pacific salmon, riverine sonar, sockeye salmon, side-scanning sonar, spawning escapement

INTRODUCTION

The Copper River drainage (Figure 1) has supported a significant commercial fishery since the early 1890's and a subsistence life style for the residents of this drainage for many years before that. Five species of Pacific salmon spawn in the Copper River. The most abundant species is sockeye salmon, which makes up more than 90 percent of the total run. Coho salmon *Oncorhynchus kisutch* comprise approximately five percent and chinook salmon *O. tshawytscha* makes up about three percent of the total run. Populations of pink *O. gorbuscha* and chum *O. keta* salmon are not abundant.

There are three major sockeye salmon spawning components in the Copper River system. The most abundant component, referred to as the upper Copper River stocks, spawn in Copper River tributaries above Miles Lake. The second component, derived from the upper Copper River stocks, is an artificially propagated Gulkana River hatchery stock. The Gulkana Hatchery, which has operated since the early 1970's, produces approximately 350,000 returning adult sockeye salmon. The third component, referred to as the lower delta stocks, spawn in systems below the Chugach Mountains, between Eyak Lake and the Katalla River.

Management of Copper River salmon resources is difficult due to several factors. The Copper River is a cold turbid system draining extensive glaciers originating in the Alaska, Chugach, Wrangell, and St. Elias mountain ranges. Enumerating the escapement within this drainage has been difficult since the main stem Copper River is too silty to allow visual counting of salmon. While it is possible to survey clear tributary streams, sockeye and chinook salmon reach these waters months after they have passed through the commercial fishery. Such surveys have little value for inseason management decisions and make it impossible to ensure that minimum escapement levels are achieved. However, postseason escapement estimates do provide data to forecast subsequent runs and to establish escapement goals.

Inseason escapement estimates first became possible in 1978 (Appendices 1 and 2), with the deployment of a single side scanning sonar salmon counter on the south bank of the Copper River at the outlet of Miles Lake (Mile 49 of the Copper River Highway), approximately 53 km upstream from the commercial fishing district (Figure 2). In 1979, an additional side-scanning sonar unit was installed on the north bank of the river. Information from this project has been used for real time management of both the commercial and personal use fisheries. During the winter of 1996 the Board of Fisheries made significant changes to The Copper River management plan, 5AAC 24.360 (State of Alaska, 1997). Emergency order regulation of the commercial fishery as well as subsistence, personal use, and sport fisheries is based on escapement information collected at the Miles Lake sonar site.

METHODS

To estimate total escapement, the sonar system must be placed in an area of the river where salmon do not mill and all salmon traveling upriver have a high probability of passing through the sonar beam. An area of the river with a single channel, uniform slope, smooth bottom and adequate current velocity is most desirable. The most suitable location, closest to the river mouth, was found just downstream of Miles Lake. This site is 53 km upstream from the Copper River commercial fishing district. This section of the river is influenced by two glaciers: Childs Glacier, which is below Miles Lake, and Miles Glacier, which is on the eastern shore of Miles Lake (Figure 3). In 1999 deployment of the sonar was delayed a few days because the south shore of the river was frozen and too much ice was flowing down the north side. Although the Copper River Highway provides access to the site, deep snowdrifts historically have rendered the highway impassable well into June most years. Since 1994, the Department of Transportation (DOT) has opened the road to the sonar site in early May. In 1998 and 1999 extreme snow depths prevented DOT from opening the road to the sonar site, and the United States Coast Guard deployed gear and personnel to the site via helicopter. Beginning in 2000, DOT will no longer be funded to remove snow from that section of road near the sonar site before the sonar needs to be deployed.

Sonar Operations

The basic adult salmon counter system consists of four main elements: an electronic counting unit, a transducer, an artificial bottom substrate, and an oscilloscope for calibration. The system is powered by a 12-volt battery continuously recharged by a solar panel.

Electronic counting units used on this project varied within and between years. Two 16 sector, 1985 Bendix units, with adjustable hit criteria by sector, are currently used. Two 12 sector 1981, Bendix units with rock inhibiting functions are available to replace 16 sector units which malfunction or are damaged.

Transducers operate at 515 kHz and have alternating beam widths of 2 and 4 degrees. Each transducer is mounted on an underwater stand near the riverbank and aimed horizontally across the river so that the beam is perpendicular to the current and slightly off the bottom. This allows monitoring the portion of river most frequently used by migrating sockeye salmon. On the north bank the transducer beam is aimed along the natural river bottom where the slope is smooth and uniform. A portable tripod is used to hold and aim the transducer. On the south bank the transducer is aimed over a permanent artificial bottom substrate with a smooth straight surface. The artificial

substrate is constructed of concrete with an embedded steel rail to form a uniform surface along the river bottom. The rail also serves as a guide along which the transducer is moved in response to water level fluctuations. Through 1995, a minimum water level of 40.1 m above mean sea level was needed for use of the artificial substrate. When water levels are lower, a portable tripod is used to hold and aim the transducer. However, in 1995 an iceberg damaged the lower portion of the rail, and the water level required to use the artificial substrate is now 40.9 m above sea level.

Each portable tripod has an adjustment wheel at the top that is manually turned to aim the sonar beam along the river bottom or substrate. To position the beam up or down river, the entire tripod must be shifted in the desired direction (Morstad 1992). These manually adjustable stands are less prone to damage by large pieces of ice and debris than remote controlled pan and tilt rotator units.

In 1999, deployment of the sonar was delayed due to a late river breakup. The north side of the river opened up first while the south side opened a few days later. The sonar on each side was installed as soon as it was safe for both sonar equipment and personnel. Fish passage was low when the sonar was first deployed (Table 1).

Calibrations

Each year, frequent adjustments of transducers have been required on both riverbanks because of large fluctuations in river level (Appendix 3), wave action caused by strong winds, and periods of heavy ice passage. The north bank sonar unit was calibrated every four hours for 30 minutes or until 100 salmon were counted. Due to the low frequency of fish passage (less than 10 fish per hour is common), calibrating the north bank can be difficult

Since 1994, when the south bank unit was on the artificial substrate, calibrations were conducted every three hours for 30 minutes or until 100 salmon were counted (Morstad 1992). When the south bank transducer was mounted on the tripod hourly printouts from the counter were discarded. Instead, visual counting with the oscilloscope was conducted every hour for 30 minutes (Table 2) and then expanded to obtain a cumulative hourly count (Table 3 and 4). During this period, the pulse repetition rate of the sonar counter was increased to increase the number of hits per fish, which aided in visual counting. The reason expanded counts from the oscilloscope were used during the low water periods in May and early June is because large amounts of shore, lake and glacial ice drift down river and cause high counts in inshore sectors of the beam. Interpolations of inshore sectors had to be made constantly, thereby producing data based on averages (Morstad 1992).

Species Apportionment

Test fishing programs using gill nets and beach seines were attempted in the vicinity of the sonar site from 1985 through 1987, but lack of good sampling locations and small catches indicated that this was not a viable way to collect data on species composition (Morstad 1992). No species apportionment information was collected at the site in 1999. Based on information from subsistence, commercial, sport and personal use harvests, as well as aerial surveys, most salmon migrating up the Copper River are sockeye salmon. Therefore, it was assumed that most sonar counts could be attributed to this species.

RESULTS and DISCUSSION

The sonar at the Miles Lake site was operated from 23 May to 3 August 1999. Estimated escapement during that time period was 850,951 salmon, 13 percent above the inriver escapement goal of 750,000 (Table 1). Daily counts were below anticipated levels from May 23 through June 9 and then surpassed anticipated levels for most of the remaining season. Cumulative escapement surpassed the anticipated cumulative escapement on June 24 and remained above the anticipated level for the remainder of the season (Figure 4). The south bank transducer was mounted on a tripod from 26 May through 11 June (Tables 2 and 4), when water level was too low to use the artificial substrate (Figure 5). Although the sonar was installed at the site five to seven days later than planned since the river was frozen, it appears most early run fish were counted. The midpoint of the escapement was reached on 1 July, which makes this run about two weeks later than the average (16 June; Appendix 2).

LITERATURE CITED

ADF&G (Alaska Department of Fish and Game). 1997. Subsistence finfish fishing regulations. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

Morstad, S. 1992. Miles Lake sonar project operational plan. 1992. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Informational Report No.2C91-12, Anchorage.

Morstad. S. 1992. Copper River hydroacoustic salmon enumeration study, 1988-1991. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Informational Report No.2C92-26, Anchorage.

TABLES

Table 1. Daily sockeye salmon escapement estimates, Miles Lake sonar, 1999.

		Estimated Daily Escapement				Escapement Objective			
Date	Water Level [a]	North Bank	South Bank	Daily	Cumulative	Daily	Cumulative	0600 Count	Projected Daily
15-May									
16-May							0		
17-May						343	343		
18-May						821	1,164		
19-May						1,154	2,318		
20-May						1,312	3,630		
21-May						1,326	4,956		
22-May	39.45					1,825	6,781		
23-May	39.34	48 [b]	912 [c]	960	960	2,689	9,470		
24-May	39.35	24	456 [c]	480	1,440	4,112	13,582		
25-May	39.43	29	571 [c]	600	2,040	4,261	17,843		
26-May	39.44	18	354 [d]	372	2,412	4,541	22,384		
27-May	39.46	41	818	859	3,271	6,492	28,877	196	784
28-May	39.44	54	1,075	1,129	4,400	8,486	37,363	134	536
29-May	39.53	189	2,268	2,457	6,857	6,139	43,502	250	1,000
30-May	39.54	295	5,899	6,194	13,051	7,242	50,745	1,082	4,328
31-May	39.42	172	3,438	3,610	16,661	9,504	60,249	998	3,992
01-Jun	39.37	105	2,095	2,200	18,861	10,030	70,279	838	3,352
02-Jun	39.55	94	1,870	1,964	20,825	11,446	81,725	416	1,664
03-Jun	39.55	117	2,349	2,466	23,291	10,939	92,663	638	2,552
04-Jun	39.56	122	2,440	2,562	25,853	12,560	105,223	719	2,876
05-Jun	39.65	135	2,700	2,835	28,688	13,840	119,063	286	1,144
06-Jun	39.87	87	1,740	1,827	30,515	12,501	131,564	725	2,900
07-Jun	40.13	235	6,224	6,459	36,974	12,223	143,788	1,076	4,304
08-Jun	40.52	346	6,924	7,270	44,244	14,382	158,170	1,702	6,808
09-Jun	40.84	441	8,829	9,270	53,514	13,653	171,822	1,163	4,652
10-Jun	41.16	707	14,146	14,853	68,367	13,101	184,923	1,900	7,600
11-Jun	41.37	1,289	25,774 [e]	27,063	95,430	12,614	197,537	6,604	26,416
12-Jun	41.45	1,261	25,224	26,485	121,915	11,749	209,286	6,571	26,284
13-Jun	41.64	240	24,632	24,872	146,787	10,225	219,511	6,918	27,672
14-Jun	41.96	934	18,688	19,622	166,409	9,739	229,250	5,620	22,480
15-Jun	42.19	819	16,377	17,196	183,605	10,587	239,838	5,973	23,892
16-Jun	42.35	895	17,907	18,802	202,407	9,507	249,345	2,962	11,848
17-Jun	42.50	500	15,521	16,021	218,428	9,437	258,782	4,555	18,220
18-Jun	42.66	481	10,179	10,660	229,088	8,181	266,963	2,453	9,812
19-Jun	42.83	638	12,369	13,007	242,095	7,441	274,404	2,875	11,500
20-Jun	42.73	1,180	13,516	14,696	256,791	7,624	282,027	3,250	13,000
21-Jun	42.62	1,622	12,480	14,102	270,893	6,899	288,926	2,991	11,964
22-Jun	42.42	519	14,226	14,745	285,638	7,385	296,311	3,993	15,972
23-Jun	42.26	330	9,938	10,268	295,906	7,822	304,133	2,991	11,964
24-Jun	42.12	164	16,751	16,915	312,821	7,499	311,631	4,515	18,060
25-Jun	42.07	196	13,844	14,040	326,861	7,606	319,237	3,426	13,704
26-Jun	42.20	207	14,944	15,151	342,012	7,078	326,315	3,718	14,872
27-Jun	42.37	399	20,146	20,545	362,557	6,890	333,205	4,548	18,192
28-Jun	42.32	576	14,391	14,967	377,524	6,621	339,826	3,484	13,936
29-Jun	42.27	527	14,314	14,841	392,365	8,034	347,860	2,434	9,736
30-Jun	42.34	328	14,178	14,506	406,871	8,333	356,193	3,117	12,468

-Continued-

Table1. (page 2 of 2)

		Estimated Daily Escapement				Escapement Objective			
Date	Water Level [a]	North Bank	South Bank	Daily	Cumulative	Daily	Cumulative	0600 Count	Projected Daily
01-Jul	42.38	314	15,753	16,067	422,938	8,621	364,814	3,351	13,404
02-Jul	42.47	134	10,810	10,944	433,882	9,784	374,598	2,520	10,080
03-Jul	42.59	87	12,926	13,013	446,895	11,049	385,647	3,016	12,064
04-Jul	42.87	104	10,102	10,206	457,101	11,705	397,352	2,555	10,220
05-Jul	43.10	55	9,161	9,216	466,317	12,818	410,170	3,057	12,228
06-Jul	43.19	120	6,744	6,864	473,181	12,645	422,815	1,659	6,636
07-Jul	43.09	247	6,449	6,696	479,877	12,684	435,498	1,489	5,956
08-Jul	43.00	340	16,000	16,340	496,217	13,789	449,288	2,412	9,648
09-Jul	42.95	404	13,973	14,377	510,594	15,581	464,869	3,123	12,492
10-Jul	42.85	395	15,204	15,599	526,193	15,263	480,132	3,298	13,192
11-Jul	42.73	334	16,785	17,119	543,312	15,428	495,560	3,817	15,268
12-Jul	42.78	393	12,656	13,049	556,361	14,792	510,352	3,729	14,916
13-Jul	42.85	411	9,831	10,242	566,603	15,598	525,950	2,620	10,480
14-Jul	42.86	586	16,135	16,721	583,324	14,400	540,350	2,139	8,556
15-Jul	42.78	680	16,869	17,549	600,873	13,575	553,925	3,749	14,996
16-Jul	43.07	397	17,835	18,232	619,105	15,439	569,364	3,758	15,032
17-Jul	43.41	609	16,032	16,641	635,746	15,192	584,556	3,824	15,296
18-Jul	43.43	634	10,790	11,424	647,170	13,192	597,747	3,258	13,032
19-Jul	43.29	1,265	14,030	15,295	662,465	12,961	610,709	1,885	7,540
20-Jul	42.93	2,522	13,555	16,077	678,542	14,284	624,993	2,519	10,076
21-Jul	42.93	1,732	14,666	16,398	694,940	10,876	635,869	3,513	14,052
22-Jul	42.96	665	7,862	8,527	703,467	9,131	645,000	2,195	8,780
23-Jul	42.96	1,294	17,924	19,218	722,685	8,355	653,355	1,720	6,880
24-Jul	42.52	1,241	15,256	16,497	739,182	8,632	661,987	2,904	11,616
25-Jul	42.29	766	15,815	16,581	755,763	7,610	669,596	4,030	16,120
26-Jul	42.13	885	13,303	14,188	769,951	6,768	676,364	3,261	13,044
27-Jul	42.13	876	7,745	8,621	778,572	7,115	683,480	2,324	9,296
28-Jul	42.34	1,130	8,519	9,649	788,221	7,731	691,210	2,761	11,044
29-Jul	42.50	1,517	8,974	10,491	798,712	7,096	698,306	1,871	7,484
30-Jul	42.59	1,709	11,504	13,213	811,925	5,937	704,243	2,456	9,824
31-Jul	42.41	1,259	6,715	7,974	819,899	5,792	710,035	1,944	7,776
01-Aug	42.48	2,447	10,592	13,039	832,938	5,383	715,419	2,030	8,120
02-Aug	42.70	2,030 [f]	8,501	10,531	843,469	4,539	719,958	2,496	9,984
03-Aug	43.17		7,482	7,482	850,951	3,960	723,918	1,597	6,388
04-Aug	43.46				850,951	4,032	727,950		

[a] Meters above sea level.

[b] North bank tripod/transducer was deployed.

[c] Extrapolated from north count only.

[d] South bank transducer was deployed on the tripod.

[e] South bank transducer was deployed on the permanent substrate at midnight.

[f] North bank tripod/transducer was pulled 12:00 midnight.

Table 2. The number of minutes each hour the oscilloscope was monitored on the south bank tripod, Miles Lake sonar, 1999.

HOUR	26-May	27-May	28-May	29-May	30-May	31-May	1-Jun	2-Jun	3-Jun	4-Jun	5-Jun	6-Jun	7-Jun	8-Jun	9-Jun	10-Jun
0000-0100		30	30	30	30	20	30	30	30	30	30	30	15	30	30	30
0100-0200		30	30	30	30	30	30	30	30	30	30	30	30	30	20	30
0200-0300		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
0300-0400		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
0400-0500		30	30	30	30	30	30	30	30	20	30	30	30	30	30	30
0500-0600		30	30	30	30	30	30	30	30	30	30	30	30	30	30	25
0600-0700		30	30	30	30	30	30	30	30	30	30	20	30	30	30	30
0700-0800		30	30	30	30	30	20	30	30	30	30	30	26	30	30	30
0800-0900	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
0900-1000	30	20	20	20	20	20	30	20	20	20	20	20	20	20	20	20
1000-1100	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
1100-1200	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
1200-1300	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
1300-1400	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
1400-1500	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
1500-1600	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
1600-1700	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
1700-1800	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
1800-1900	30	30	30	30	30	30	30	30	30	30	30	30	30	15	30	30
1900-2000	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
2000-2100	30	30	30	30	30	30	30	30	30	30	30	6	30	30	30	30
2100-2200	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
2200-2300	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	14
2300-2400	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	32
TOTAL	480	710	710	710	710	700	710	710	710	700	710	676	691	695	700	691

Table 3. The number of fish observed passing the south bank tripod during visual monitoring of the oscilloscope, Miles Lake sonar, 1999.

HOUR	26-May	27-May	28-May	29-May	30-May	31-May	1-Jun	2-Jun	3-Jun	4-Jun	5-Jun	6-Jun	7-Jun	8-Jun	9-Jun	10-Jun
0000-0100		21	3	20	110	76	67	41	50	35	9	61	32	121	154	140
0100-0200		5	12	11	87	95	110	25	47	64	27	63	102	119	13	145
0200-0300		5	13	48	117	92	105	34	74	74	20	53	93	152	61	194
0300-0400		5	12	9	81	61	48	38	43	60	22	50	84	143	67	166
0400-0500		22	8	15	25	56	48	33	37	35	48	61	116	146	217	178
0500-0600		40	19	22	121	81	41	37	68	74	17	31	79	170	63	106
0600-0700		11	14	8	115	68	34	25	34	56	32	29	126	151	66	164
0700-0800		14	7	17	128	59	31	19	33	58	47	31	50	117	158	166
0800-0900	15	27	7	22	106	85	28	37	55	68	82	72	110	152	221	305
0900-1000	13	18	17	38	131	52	35	18	59	53	48	37	69	82	194	152
1000-1100	6	24	16	39	94	70	56	20	70	76	98	45	134	167	288	271
1100-1200	9	28	28	48	154	70	17	27	32	64	102	47	120	167	167	384
1200-1300	9	26	40	39	92	62	32	41	46	58	71	21	102	133	269	376
1300-1400	5	11	15	89	160	97	40	16	51	57	77	13	211	147	240	367
1400-1500	4	11	24	27	167	75	43	30	79	38	101	28	189	159	158	348
1500-1600	2	10	94	67	206	46	46	38	45	41	84	12	91	151	294	435
1600-1700	4	21	27	64	117	28	18	32	48	41	58	7	182	146	304	503
1700-1800	14	15	17	24	155	43	35	65	44	21	49	25	256	149	252	534
1800-1900	8	15	20	29	84	51	38	33	27	38	101	23	209	52	207	521
1900-2000	5	9	14	82	88	39	27	38	46	36	76	10	165	182	79	684
2000-2100	9	11	24	94	139	69	24	26	52	35	61	2	99	156	212	390
2100-2200	8	21	20	118	123	67	39	48	47	31	60	13	129	148	214	217
2200-2300	6	18	19	109	179	90	36	88	33	36	21	19	125	136	233	18
2300-2400	1	12	59	76	105	123	34	117	25	27	15	76	165	123	180	204
TOTAL	118	400	529	1,115	2,884	1,655	1,032	926	1,145	1,176	1,326	829	3,038	3,369	4,311	6,968

Table 4. Expanded hourly and daily counts from the south bank tripod, Miles Lake sonar, 1999.

HOUR	26-May	27-May	28-May	29-May	30-May	31-May	1-Jun	2-Jun	3-Jun	4-Jun	5-Jun	6-Jun	7-Jun	8-Jun	9-Jun	10-Jun
0000-0100		42	6	40	220	228	134	82	100	70	18	122	128	242	308	280
0100-0200		10	24	22	174	190	220	50	94	128	54	126	204	238	39	290
0200-0300		10	26	96	234	184	210	68	148	148	40	106	186	304	122	388
0300-0400		10	24	18	162	122	96	76	86	120	44	100	168	286	134	332
0400-0500		44	16	30	50	112	96	66	74	105	96	122	232	292	434	356
0500-0600		80	38	44	242	162	82	74	136	148	34	62	158	340	126	254
0600-0700		22	28	16	230	136	68	50	68	112	64	87	252	302	132	328
0700-0800		28	14	34	256	118	93	38	66	116	94	62	115	234	316	332
0800-0900	30	54	14	44	212	170	56	74	110	136	164	144	220	304	442	610
0900-1000	26	54	51	114	393	156	70	54	177	159	144	111	207	246	582	456
1000-1100	12	48	32	78	188	140	112	40	140	152	196	90	268	334	576	542
1100-1200	18	56	56	96	308	140	34	54	64	128	204	94	240	334	334	768
1200-1300	18	52	80	78	184	124	64	82	92	116	142	42	204	266	538	752
1300-1400	10	22	30	178	320	194	80	32	102	114	154	26	422	294	480	734
1400-1500	8	22	48	54	334	150	86	60	158	76	202	56	378	318	316	696
1500-1600	4	20	188	134	412	92	92	76	90	82	168	24	182	302	588	870
1600-1700	8	42	54	128	234	56	36	64	96	82	116	14	364	292	608	1,006
1700-1800	28	30	34	48	310	86	70	130	88	42	98	50	512	298	504	1,068
1800-1900	16	30	40	58	168	102	76	66	54	76	202	46	418	208	414	1,042
1900-2000	10	18	28	164	176	78	54	76	92	72	152	20	330	364	158	1,368
2000-2100	18	22	48	188	278	138	48	52	104	70	122	20	198	312	424	780
2100-2200	16	42	40	236	246	134	78	96	94	62	120	26	258	296	428	434
2200-2300	12	36	38	218	358	180	72	176	66	72	42	38	250	272	466	77
2300-2400	2	24	118	152	210	246	68	234	50	54	30	152	330	246	360	383
TOTAL	236	818	1,075	2,268	5,899	3,438	2,095	1,870	2,349	2,440	2,700	1,740	6,224	6,924	8,829	14,146
DAILY	354	818	1,075	2,268	5,899	3,438	2,095	1,870	2,349	2,440	2,700	1,740	6,224	6,924	8,829	14,146

FIGURES

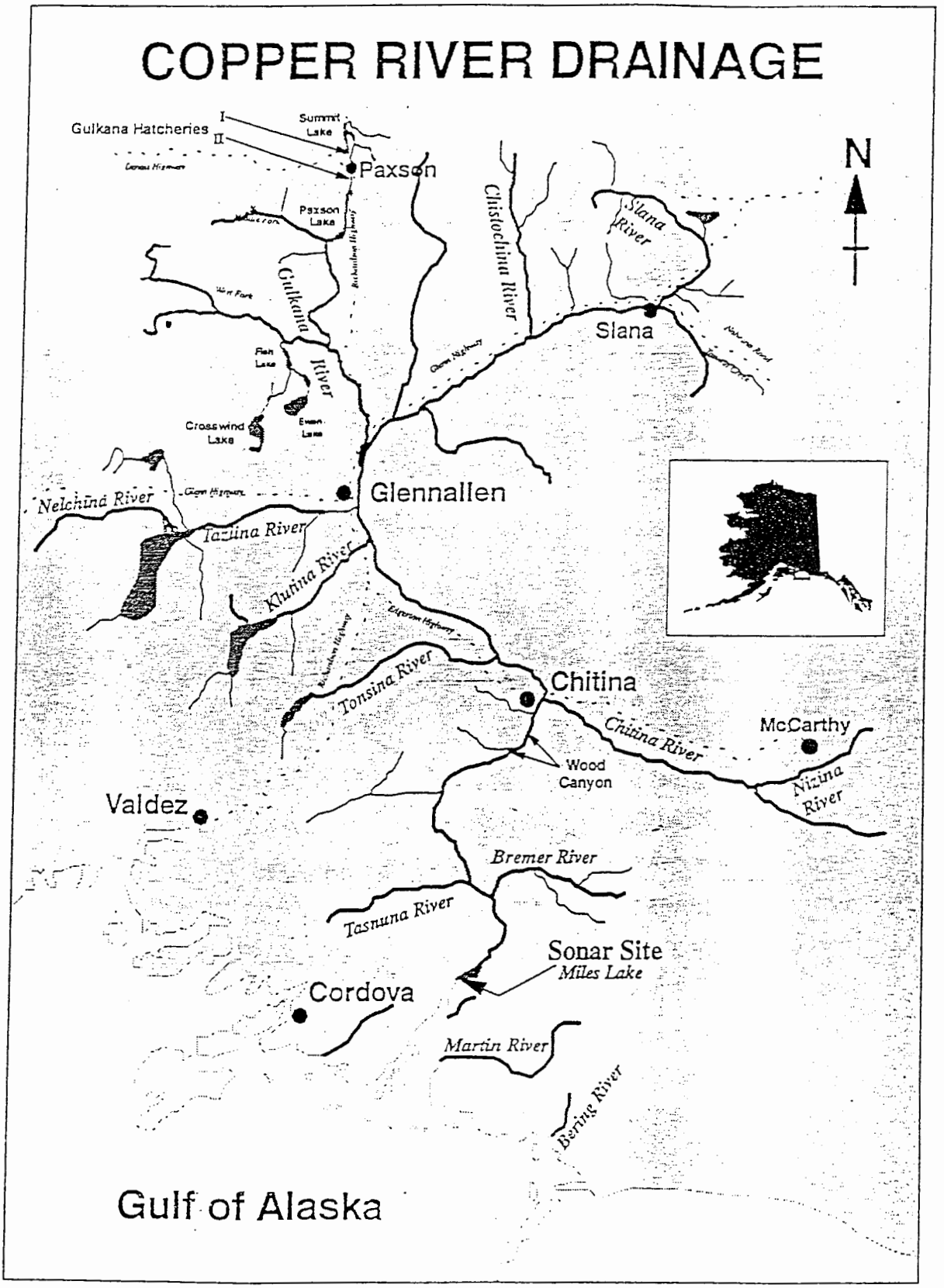

Figure 1. The Copper River and Copper River delta area.

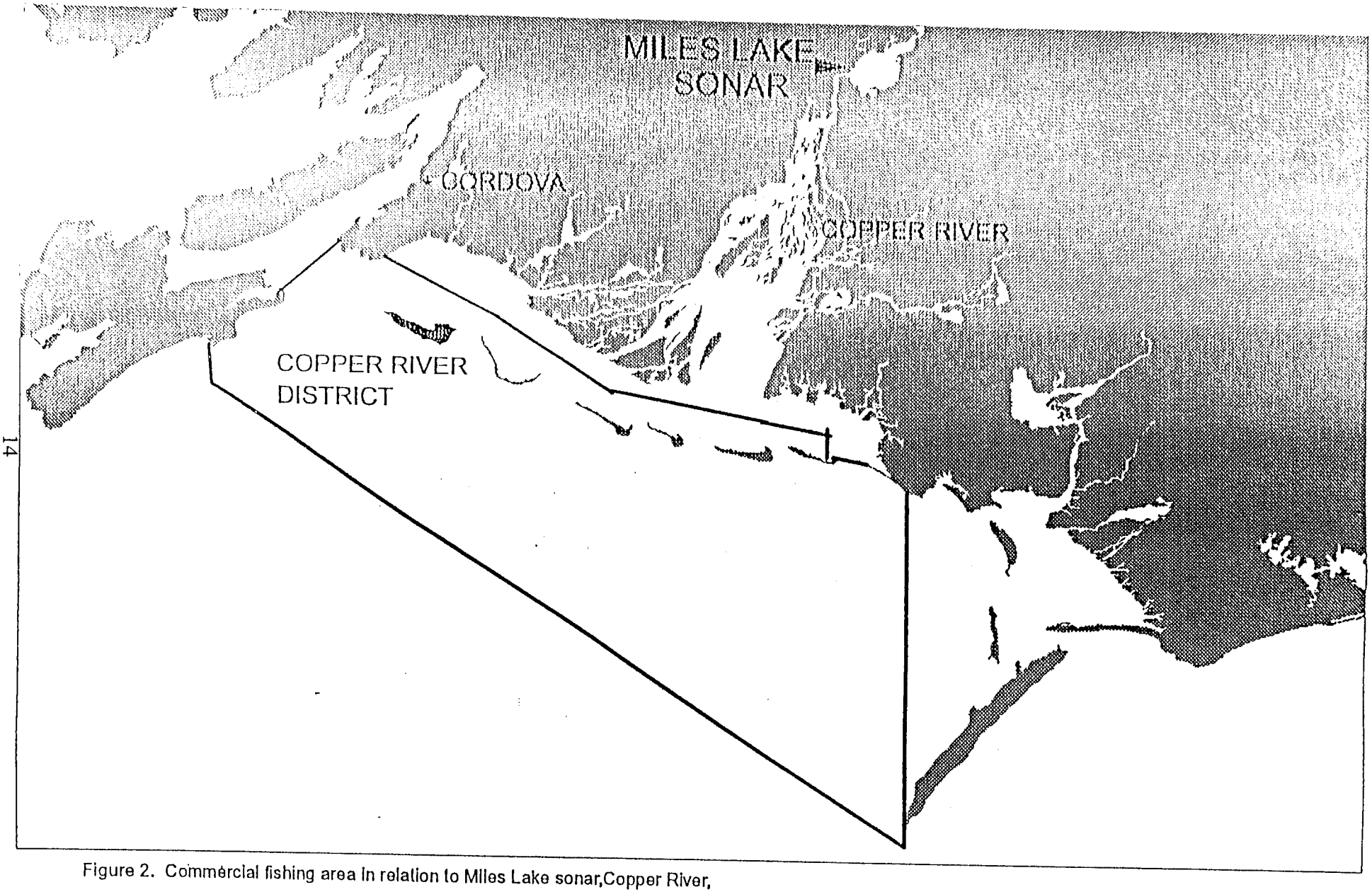

Figure 2. Commercial fishing area in relation to Miles Lake sonar,Copper River,

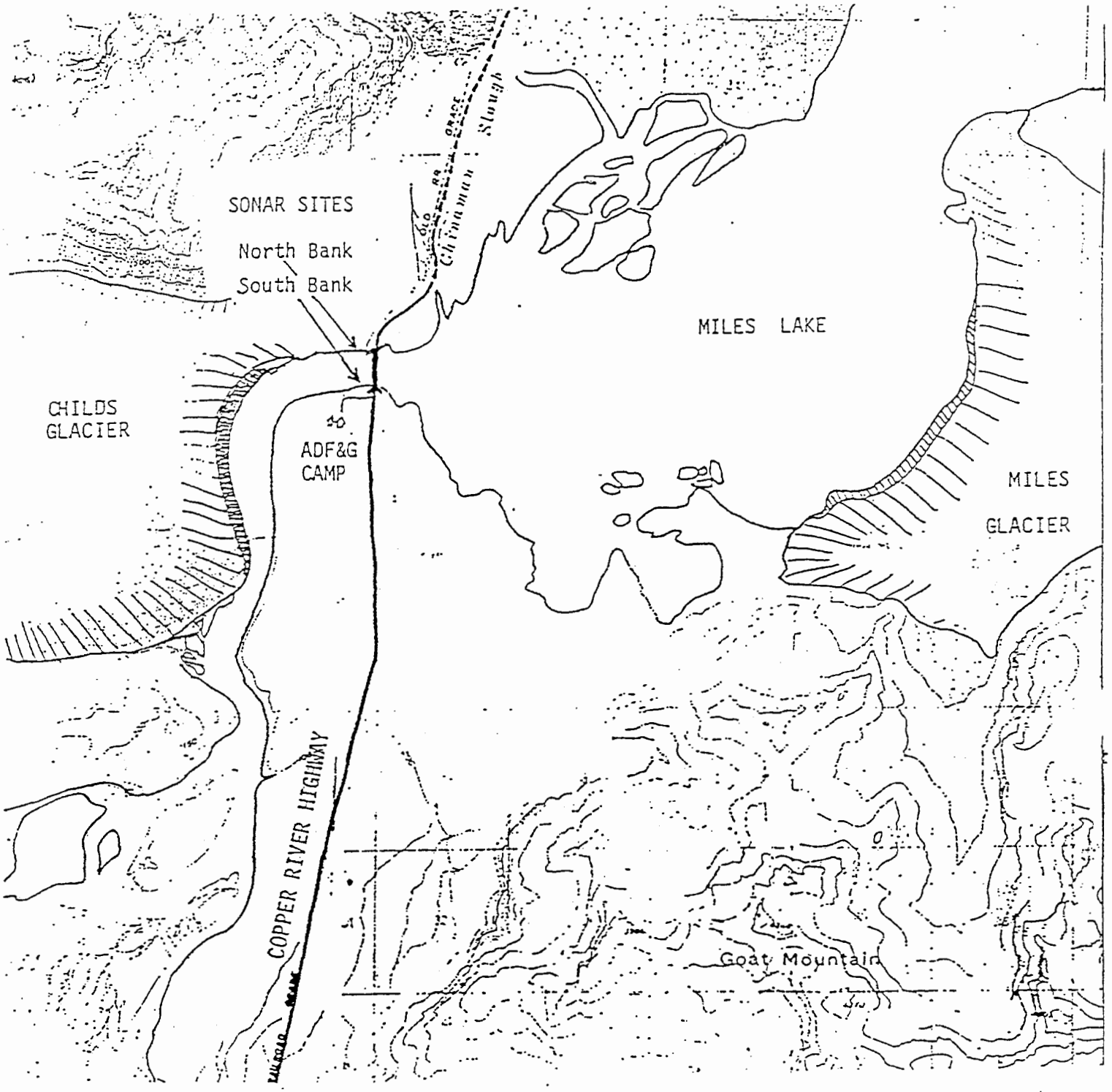

Figure3. North and south bank sonar sites,Miles Lake area,Copper River.

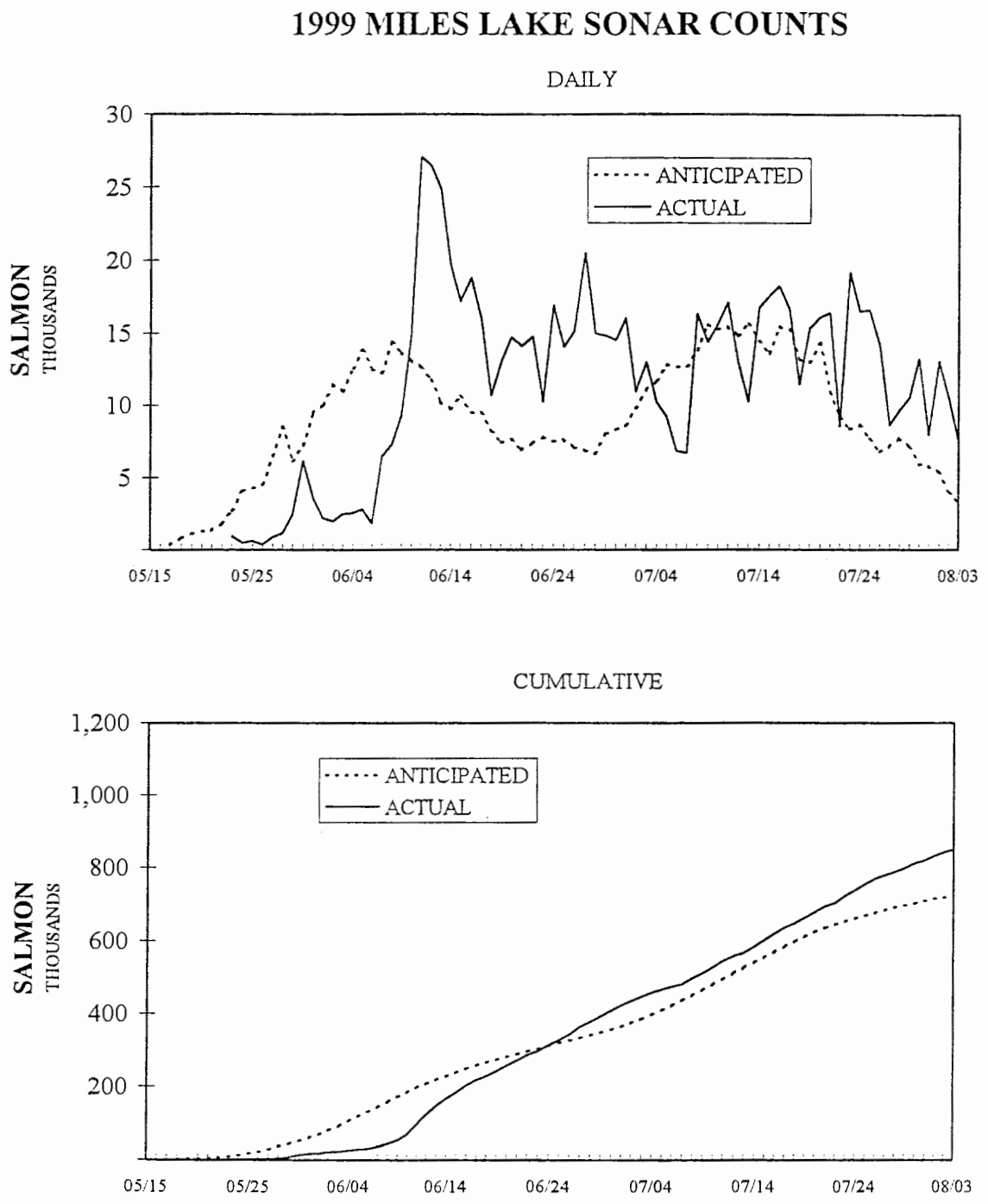

Figure 4. Anticipated versus actual daily and cumulative salmon escapement, Miles Lake sonar, 1999.

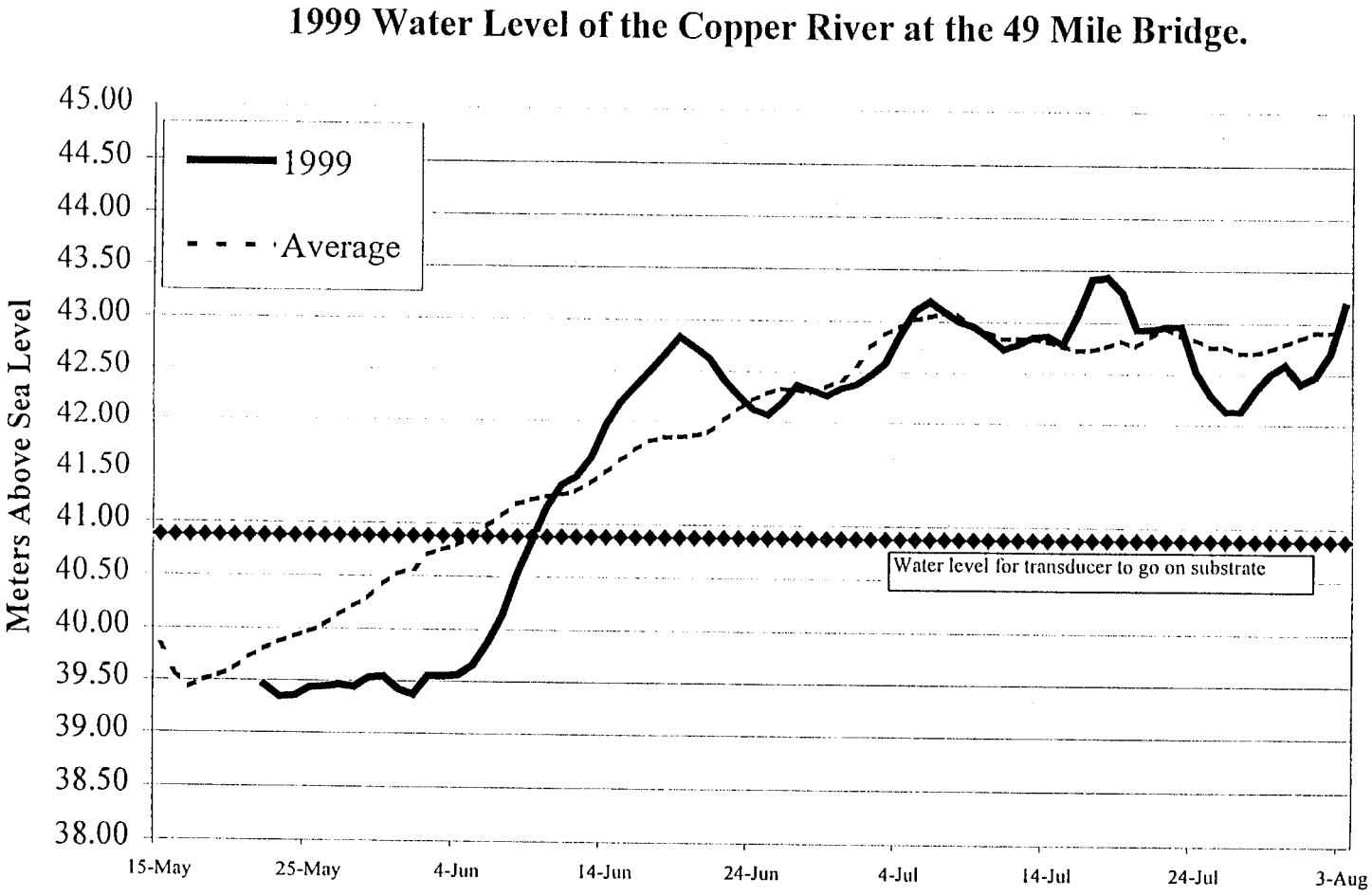

Figure 5. Daily water levels for 1999 versus the average 1983 - 1998, Copper River, Alaska.

APPENDICES

Appendix 1. Daily salmon escapement estimates, Miles Lake sonar, Copper River, 1978-1999.

Date	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
15-May												
16-May												
17-May				5,372								732
18-May		381	218	9,665								3,660
19-May		487	167	11,409			725				313	6,588
20-May		847	221	10,733			1,924			167	877	6,935
21-May		1,199	88	9,729			1,986			36	1,140	4,834
22-May		1,916	391	7,558			5,124			482	2,256	4,030
23-May		2,901	594	6,214		3,310	5,042			1,732	5,078	6,472
24-May		3,402	494	12,985	90	8,620	4,486			2,040	11,033	7,448
25-May		2,397	713	12,816	493	11,587	3,120		534	4,263	9,979	4,658
26-May	502	4,927	1,057	6,383	1,023	10,575	4,645		1,694	7,115	8,946	8,318
27-May	837	6,821	2,115	2,842	12,091	8,661	5,836		2,092	12,176	13,247	13,143
28-May	1,047	2,768	1,693	2,560	47,303	8,456	4,978	1,031	3,384	16,392	14,201	13,880
29-May	661	3,905	1,080	2,160	19,671	6,380	7,126	417	2,393	14,485	10,022	10,677
30-May	3,241	7,482	1,903	11,822	8,781	8,296	4,951	599	3,173	18,196	6,806	5,375
31-May	2,549	8,655	3,620	21,126	11,389	17,123	4,278	1,758	4,150	18,540	7,586	7,316
01-Jun	2,616	4,078	5,257	18,415	15,385	18,428	8,536	3,462	7,001	16,395	5,205	7,041
02-Jun	2,811	3,465	7,061	23,771	17,213	14,414	8,483	6,726	20,638	14,385	3,558	5,234
03-Jun	1,837	3,536	7,437	16,716	13,383	13,137	9,730	10,691	20,237	17,666	4,626	6,867
04-Jun	3,256	2,778	8,996	9,755	12,355	15,357	12,496	24,272	26,626	14,632	7,877	8,555
05-Jun	2,970	4,352	9,746	10,478	14,806	19,110	16,728	30,507	27,934	10,962	6,755	7,512
06-Jun	3,318	6,453	5,407	11,975	15,585	14,069	18,097	32,953	14,527	4,322	8,895	7,719
07-Jun	3,808	7,031	2,093	13,585	12,506	19,309	18,515	27,256	9,658	5,755	9,096	12,693
08-Jun	3,275	11,078	1,349	14,412	8,430	16,094	26,619	30,925	24,938	6,366	11,322	14,565
09-Jun	2,252	7,985	3,543	15,694	7,017	11,415	20,476	29,702	28,242	7,922	14,641	9,440
10-Jun	3,475	5,205	7,301	12,856	7,599	8,009	19,275	12,010	29,952	11,553	15,216	12,126
11-Jun	2,490	4,426	12,032	7,877	7,879	9,563	17,237	11,826	25,418	11,194	16,255	9,663
12-Jun	2,082	2,227	11,584	4,844	8,587	13,292	21,706	8,231	16,494	6,506	14,959	8,256
13-Jun	2,419	3,903	7,600	3,556	9,932	13,444	12,072	6,829	11,453	4,053	10,751	10,626
14-Jun	2,835	2,563	5,661	5,228	12,551	13,831	5,981	6,800	11,393	8,053	9,382	13,548
15-Jun	2,913	3,351	7,308	7,071	12,677	15,915	10,291	8,825	8,747	5,485	9,910	9,922
16-Jun	2,782	3,473	5,655	6,885	13,595	7,938	13,930	9,347	10,099	5,516	6,484	8,889
17-Jun	2,779	4,640	7,189	6,467	12,030	5,671	19,809	6,270	8,772	5,406	4,910	10,020
18-Jun	2,261	3,911	6,741	4,565	6,544	5,689	12,850	3,738	9,050	4,815	6,469	11,131
19-Jun	3,035	3,413	2,391	2,985	4,369	6,461	7,474	3,251	7,910	3,983	7,855	8,345
20-Jun	3,035	1,954	3,597	2,891	3,352	7,382	9,258	2,423	7,240	3,933	7,952	7,575
21-Jun	2,515	2,223	4,142	3,446	3,346	8,124	7,159	2,061	6,741	3,924	5,770	7,169
22-Jun	2,068	2,585	3,954	3,997	4,467	8,005	5,522	2,763	9,026	6,379	6,985	8,868
23-Jun	2,841	2,865	3,896	4,363	7,031	7,528	5,913	3,369	8,010	10,111	7,699	5,850
24-Jun	2,616	1,877	5,217	4,651	6,329	6,009	6,741	2,950	6,968	15,708	5,582	3,927
25-Jun	2,130	3,013	5,104	3,398	4,903	5,226	6,503	1,585	5,731	16,517	5,597	2,996
26-Jun	1,771	1,973	3,595	2,412	4,416	5,638	4,385	2,381	5,410	12,500	6,378	3,426
27-Jun	2,178	1,315	3,421	2,507	2,732	4,738	7,224	3,035	5,153	7,010	6,559	3,240
28-Jun	1,103	1,697	4,324	2,949	2,174	4,771	6,728	2,264	5,022	5,644	6,259	6,302
29-Jun	1,604	1,450	3,845	3,421	2,130	4,304	4,453	2,147	3,578	6,836	8,220	6,490
30-Jun	1,632	1,899	3,465	2,378	2,313	6,146	6,449	2,139	3,771	4,636	6,497	7,354

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Appendix 1. (page 2 of 4)

Date	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
01-Jul	1,587	2,651	3,559	2,723	2,190	6,106	8,226	2,620	3,584	2,012	5,602	7,930
02-Jul	2,533	2,524	3,365	2,606	4,420	6,113	7,554	2,608	3,152	3,406	4,680	5,296
03-Jul	2,527	2,859	4,104	2,548	5,751	6,026	8,581	1,819	2,311	4,096	4,222	4,976
04-Jul	2,980	3,806	2,934	4,094	5,245	6,943	6,515	3,536	1,805	7,100	3,532	7,369
05-Jul	2,269	3,008	2,879	4,256	4,995	5,347	6,662	3,254	1,499	4,351	3,304	10,739
06-Jul	1,623	1,996	3,025	3,476	6,300	3,973	5,449	4,664	2,809	3,393	3,510	10,024
07-Jul	1,152	892	3,291	3,863	6,171	4,209	4,040	3,627	2,991	5,617	4,324	10,236
08-Jul	831	2,091	2,995	3,774	3,990	4,080	3,906	3,893	2,860	6,616	8,499	11,113
09-Jul	947	3,190	2,817	3,449	2,210	3,353	3,210	6,827	3,077	6,352	5,167	10,761
10-Jul	1,252	4,209	3,642	2,942	2,070	3,644	2,927	10,607	5,435	8,585	6,347	9,506
11-Jul	841	3,684	5,763	2,271	1,980	4,454	3,608	5,457	5,115	5,322	7,620	8,453
12-Jul	341	3,262	4,788	3,468	3,420	4,541	4,280	6,329	5,042	5,757	7,881	11,953
13-Jul	167	3,144	1,725	2,265	4,032	4,543	4,582	5,252	3,696	6,583	7,087	9,329
14-Jul	290	4,124	1,679	2,596	4,339	5,819	6,573	6,113	3,530	6,439	7,012	10,270
15-Jul	275	3,535	1,743	3,691	4,714	6,496	5,521	5,024	4,699	5,722	6,924	12,283
16-Jul	538	5,175	2,515	2,580	3,561	6,970	6,755	5,339	2,227	6,259	5,457	10,897
17-Jul	304	3,555	3,419	780	2,925	6,327	4,955	5,960	4,108	4,467	4,877	8,903
18-Jul	284	3,760	5,878	8,633	3,413	4,326	4,736	5,110	4,993	4,620	3,857	11,811
19-Jul	321	3,344	5,613	20,975	4,296	3,703	3,140	4,560	6,066	4,127	4,583	10,567
20-Jul	238	2,716	5,060	20,511	3,920	3,988	3,389	8,176	5,997	3,634	4,483	10,169
21-Jul	81	2,583	3,826	15,741	4,049	4,463	3,204	4,128	4,746	2,441	3,964	8,639
22-Jul	18	2,012	3,173	6,566	3,871	4,881	3,780	3,158	3,408	1,273	2,797	8,908
23-Jul	15	1,915	2,143	5,787	3,099	3,603	3,205	2,870	2,909	1,002	3,429	8,103
24-Jul	40	2,182	1,353	5,063	3,061	3,903	2,198	2,162	2,633	625	3,900	6,250
25-Jul	13	1,112	1,623	3,391	3,374	4,535	1,937	2,449	2,292	2,014	4,023	5,303
26-Jul		771	1,256	2,493	2,596	3,839	1,687	1,974	1,799	368	4,142	5,706
27-Jul		318	1,198	2,451	2,247	3,687	1,391	2,191	1,626	626	3,920	5,699
28-Jul		387	698	2,785	2,375	5,234	1,004	2,839	1,797	2,494	3,452	4,926
29-Jul		365	400	3,686	1,426	4,138	891	2,813	1,563	2,341	3,476	4,150
30-Jul		491	470	3,814	963	3,512	938	2,790	1,489	2,075	2,423	2,519
31-Jul		703	353	3,802	1,176	1,835	1,093	1,848	1,259	2,226	1,920	1,551
01-Aug		758	825	3,396	511	1,912	1,047	1,070	1,172	2,726	1,438	2,299
02-Aug		379	1,034	2,304	942	2,211	1,088	703	1,045	1,299	1,098	1,744
03-Aug		227	764	1,913	494	2,088	1,213		770	1,702		
04-Aug		286	708	1,297	581	2,897	1,118		814	1,499		
05-Aug		173	758	1,181	122		1,009		435	518		
06-Aug		103	877	1,170			533		416			
07-Aug		76	615						192			
08-Aug			166						33			
09-Aug			239						47			
Total	107,011	237,173	276,538	535,263	467,306	545,724	536,806	436,313	508,600	483,478	488,098	607,797

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Appendix 1. (page 3 of 4)

Date	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Average
15-May						491					
16-May						468		64			
17-May					448	532		88			1,195
18-May					686	522	84	136	158		1,723
19-May					952	1,331	72	168	254		2,042
20-May				9,503	955	3,028	130	486	173		2,768
21-May	1,121	1,087		13,677	1,610	3,504	338	464	1,477		2,819
22-May	4,843	1,717		22,706	2,422	2,808	1,023	1,742	1,277		4,020
23-May	7,177	3,161		28,425	3,558	4,301	1,766	2,744	1,327	960	4,986
24-May	11,923	2,465		31,980	2,897	2,473	1,330	12,196	3,582	480	6,662
25-May	14,333	3,046		38,581	4,083	1,841	1,363	26,923	5,851	600	7,746
26-May	11,337	3,274		23,647	3,282	3,032	2,192	27,389	5,608	372	6,766
27-May	12,060	3,893	1,226	12,885	2,855	3,806	4,790	31,978	9,011	859	7,773
28-May	7,434	3,389	1,431	17,476	3,047	7,168	12,856	46,182	10,275	1,129	10,367
29-May	9,176	3,933	2,362	13,156	2,888	9,878	12,008	46,539	11,226	2,457	8,755
30-May	9,541	4,417	5,736	8,478	1,966	12,779	10,861	37,554	18,442	6,194	8,936
31-May	10,343	9,362	7,931	16,686	4,616	10,755	19,994	46,197	23,018	3,610	11,846
01-Jun	10,026	16,833	6,610	16,473	9,423	8,980	25,530	31,557	21,312	2,200	11,853
02-Jun	9,909	21,151	7,919	22,831	7,767	9,428	25,977	30,744	24,206	1,964	13,166
03-Jun	8,576	17,808	11,535	14,591	3,137	5,647	27,265	18,078	25,724	2,466	11,850
04-Jun	7,572	14,557	7,921	17,585	6,143	6,745	22,231	17,562	25,530	2,562	12,517
05-Jun	10,173	18,673	9,295	25,779	5,265	5,895	18,009	16,188	19,064	2,835	13,320
06-Jun	10,410	11,688	14,552	25,643	12,100	9,236	11,310	19,985	14,130	1,827	12,464
07-Jun	11,137	8,440	16,734	18,068	16,732	8,044	16,743	22,612	18,601	6,459	12,949
08-Jun	7,637	9,471	17,729	20,762	18,022	5,738	26,585	33,969	13,719	7,270	15,013
09-Jun	9,905	11,665	20,719	24,997	18,042	5,479	35,684	37,078	7,325	9,270	15,386
10-Jun	11,660	8,565	23,430	19,794	17,588	8,054	31,792	34,180	10,494	14,853	14,772
11-Jun	16,181	8,104	18,591	11,119	12,272	11,950	29,085	30,941	18,471	27,063	14,529
12-Jun	23,929	12,688	14,096	18,322	13,008	7,274	35,637	19,119	17,681	26,485	13,955
13-Jun	24,448	9,066	18,257	12,872	9,081	8,945	27,036	13,364	21,718	24,872	12,104
14-Jun	14,302	9,236	20,456	8,357	15,639	14,021	14,958	16,080	28,281	19,622	11,763
15-Jun	8,390	14,967	23,957	13,351	11,679	11,853	15,548	23,220	20,869	17,196	11,975
16-Jun	10,112	14,367	13,914	14,247	14,227	19,732	13,809	16,989	17,261	18,802	11,275
17-Jun	12,695	10,129	14,509	7,621	11,445	19,918	10,298	21,801	20,761	16,021	10,871
18-Jun	8,052	11,051	14,893	4,921	17,223	17,938	7,359	22,092	18,535	10,660	9,568
19-Jun	9,763	12,921	12,324	6,324	19,392	16,025	15,303	12,711	11,618	13,007	8,675
20-Jun	9,315	14,146	19,480	4,900	11,498	16,863	12,071	7,844	11,500	14,696	8,314
21-Jun	10,292	8,750	16,882	3,536	11,699	15,430	7,570	8,389	12,276	14,102	7,525
22-Jun	10,157	7,830	9,452	2,864	13,305	9,862	10,851	17,553	10,788	14,745	7,819
23-Jun	10,166	6,358	7,234	5,069	18,686	5,320	15,544	7,705	10,907	10,268	7,579
24-Jun	9,340	5,963	6,319	6,071	24,282	7,357	10,226	5,310	13,521	16,915	7,904
25-Jun	10,010	7,660	6,675	4,321	14,140	9,211	7,963	5,460	13,001	14,040	7,054
26-Jun	6,812	9,500	7,180	2,718	12,204	9,989	8,668	7,985	11,217	15,151	6,623
27-Jun	9,234	10,355	6,266	3,370	14,146	16,025	10,255	12,011	10,722	20,545	7,366
28-Jun	6,881	10,810	8,084	4,361	9,213	13,673	9,195	10,427	12,822	14,967	6,803
29-Jun	4,499	10,439	9,258	4,976	15,859	9,723	12,621	10,409	15,851	14,841	7,134
30-Jun	3,975	9,113	7,416	8,384	10,845	4,402	13,091	13,741	14,681	14,506	6,765

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Appendix 1. (page 4 of 4)

Date	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Average
01-Jul	4,323	7,303	7,120	7,639	10,359	5,730	15,487	12,724	13,646	16,067	6,781
02-Jul	5,067	5,109	5,591	5,720	9,802	5,218	13,066	13,566	11,432	10,944	6,081
03-Jul	4,682	6,335	4,641	5,145	9,965	4,851	12,949	15,430	11,036	13,013	6,267
04-Jul	5,665	6,680	5,413	5,527	8,782	4,291	12,956	14,618	8,549	10,206	6,298
05-Jul	7,998	5,845	4,424	6,339	6,196	7,787	8,829	13,448	9,625	9,216	6,012
06-Jul	7,749	6,213	6,987	6,431	9,544	8,172	8,818	11,024	8,757	6,864	5,946
07-Jul	5,700	6,222	7,361	9,229	9,921	6,620	9,007	11,534	10,018	6,696	6,033
08-Jul	5,192	7,069	5,758	10,386	7,947	4,272	8,424	13,736	9,350	16,340	6,506
09-Jul	5,153	6,453	11,937	11,105	9,391	6,845	7,802	7,877	11,307	14,377	6,528
10-Jul	6,620	4,610	9,139	9,566	14,539	14,846	9,792	13,757	13,562	15,599	7,873
11-Jul	5,402	4,477	8,380	7,364	13,656	9,368	10,608	16,698	17,782	17,119	7,519
12-Jul	9,338	4,818	7,959	6,819	16,223	6,467	11,805	10,159	17,661	13,049	7,516
13-Jul	11,432	3,969	6,741	5,615	13,924	5,978	10,829	9,249	16,079	10,242	6,657
14-Jul	8,206	7,498	8,574	7,673	13,333	9,602	9,959	12,908	8,263	16,721	7,342
15-Jul	8,309	7,550	8,971	6,112	10,161	11,587	9,465	15,751	10,882	17,549	7,589
16-Jul	6,093	9,671	7,683	6,880	7,955	5,935	11,311	13,956	9,184	18,232	7,053
17-Jul	6,259	9,668	6,718	5,175	7,642	10,858	11,586	15,111	7,378	16,641	6,710
18-Jul	5,726	7,340	8,807	5,398	7,063	10,642	7,234	9,864	6,583	11,424	6,432
19-Jul	5,975	7,513	8,615	6,782	4,675	8,164	6,373	11,268	6,183	15,295	6,915
20-Jul	4,315	10,681	7,102	7,417	3,922	7,003	5,609	11,374	6,934	16,077	6,942
21-Jul	2,534	10,268	4,898	7,844	7,756	5,354	7,439	9,976	7,790	16,398	6,278
22-Jul	2,457	9,702	4,612	9,241	13,476	4,596	7,282	6,749	7,347	8,527	5,356
23-Jul	3,901	9,017	5,426	14,012	14,447	4,256	6,734	7,037	5,953	19,218	5,822
24-Jul	2,883	4,245	3,821	12,723	10,424	4,255	8,883	5,211	4,768	16,497	4,867
25-Jul	2,050	3,066	2,984	9,048	13,043	3,310	9,120	3,593	5,366	16,581	4,556
26-Jul	2,257	4,422	3,412	6,406	5,897	3,190	7,536	3,478	3,806	14,188	3,868
27-Jul	2,885	3,884	3,619	7,465	4,888	5,196	4,834	4,270	3,512	8,621	3,549
28-Jul	1,934	4,793	3,205	5,972	5,467	5,093	8,560	4,489	4,430	9,649	3,885
29-Jul	2,808	5,354	3,954	6,116	3,996	5,973	7,389	3,318	3,843	10,491	3,738
30-Jul	2,462	4,711	3,872	6,503	3,156	6,281	5,481	3,254	5,199	13,213	3,601
31-Jul	2,550	2,901	3,855	5,539	3,686	5,039	3,915	2,579	4,810	7,974	2,886
01-Aug	3,839			4,560	4,014	3,425	4,065	4,396	3,189	13,039	3,036
02-Aug	5,249			4,209		1,589	4,253	4,709	3,490	10,531	2,660
03-Aug							4,383	5,014	2,974	7,482	2,419
04-Aug							5,082		2,004		1,629
05-Aug							6,929				1,391
06-Aug							5,424				1,421
07-Aug											294
08-Aug											100
09-Aug											143
Total	581,859	579,435	601,952	833,387	715,577	599,267	906,239	1,148,079	866,957	850,951	

Appendix 2. Cumulative daily salmon escapement estimates, Miles Lake sonar, Copper River, 1978-1999.

Date	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
15-May												
16-May												
17-May				5,372								732
18-May		381	218	15,037								4,392
19-May		868	385	26,446			725				313	10,980
20-May		1,715	606	37,179			2,649			167	1,190	17,915
21-May		2,914	694	46,908			4,635			203	2,330	22,749
22-May		4,830	1,085	54,466			9,759			685	4,586	26,779
23-May		7,731	1,679	60,680		3,310	14,801			2,417	9,664	33,251
24-May		11,133	2,173	73,665	90	11,930	19,287			4,457	20,697	40,699
25-May		13,530	2,886	86,481	583	23,517	22,407		534	8,720	30,676	45,357
26-May	502	18,457	3,943	92,864	1,606	34,092	27,052		2,228	15,835	39,622	53,675
27-May	1,339	25,278	6,058	95,706	13,697	42,753	32,888		4,320	28,011	52,869	66,818
28-May	2,386	28,046	7,751	98,266	61,000	51,209	37,866	1,031	7,704	44,403	67,070	80,698
29-May	3,047	31,951	8,831	100,426	80,671	57,589	44,992	1,448	10,097	58,888	77,092	91,375
30-May	6,288	39,433	10,734	112,248	89,452	65,885	49,943	2,047	13,270	77,084	83,898	96,750
31-May	8,837	48,088	14,354	133,374	100,841	83,008	54,221	3,805	17,420	95,624	91,484	104,066
01-Jun	11,453	52,166	19,611	151,789	116,226	101,436	62,757	7,267	24,421	112,019	96,689	111,107
02-Jun	14,264	55,631	26,672	175,560	133,439	115,850	71,240	13,993	45,059	126,404	100,247	116,341
03-Jun	16,101	59,167	34,109	192,276	146,822	128,987	80,970	24,684	65,296	144,070	104,873	123,208
04-Jun	19,357	61,945	43,105	202,031	159,177	144,344	93,466	48,956	91,922	158,702	112,750	131,763
05-Jun	22,327	66,297	52,851	212,509	173,983	163,454	110,194	79,463	119,856	169,664	119,505	139,275
06-Jun	25,645	72,750	58,258	224,484	189,568	177,523	128,291	112,416	134,383	173,986	128,400	146,994
07-Jun	29,453	79,781	60,351	238,069	202,074	196,832	146,806	139,672	144,041	179,741	137,496	159,687
08-Jun	32,728	90,859	61,700	252,481	210,504	212,926	173,425	170,597	168,979	186,107	148,818	174,252
09-Jun	34,980	98,844	65,243	268,175	217,521	224,341	193,901	200,299	197,221	194,029	163,459	183,692
10-Jun	38,455	104,049	72,544	281,031	225,120	232,350	213,176	212,309	227,173	205,582	178,675	195,818
11-Jun	40,945	108,475	84,576	288,908	232,999	241,913	230,413	224,135	252,591	216,776	194,930	205,481
12-Jun	43,027	110,702	96,160	293,752	241,586	255,205	252,119	232,366	269,085	223,282	209,889	213,737
13-Jun	45,446	114,605	103,760	297,308	251,518	268,649	264,191	239,195	280,538	227,335	220,640	224,363
14-Jun	48,281	117,168	109,421	302,536	264,069	282,480	270,172	245,995	291,931	235,388	230,022	237,911
15-Jun	51,194	120,519	116,729	309,607	276,746	298,395	280,463	254,820	300,678	240,873	239,932	247,833
16-Jun	53,976	123,992	122,384	316,492	290,341	306,333	294,393	264,167	310,777	246,389	246,416	256,722
17-Jun	56,755	128,632	129,573	322,959	302,371	312,004	314,202	270,437	319,549	251,795	251,326	266,742
18-Jun	59,016	132,543	136,314	327,524	308,915	317,693	327,052	274,175	328,599	256,610	257,795	277,873
19-Jun	62,051	135,956	138,705	330,509	313,284	324,154	334,526	277,426	336,509	260,593	265,650	286,218
20-Jun	65,086	137,910	142,302	333,400	316,636	331,536	343,784	279,849	343,749	264,526	273,602	293,793
21-Jun	67,601	140,133	146,444	336,846	319,982	339,660	350,943	281,910	350,490	268,450	279,372	300,962
22-Jun	69,669	142,718	150,398	340,843	324,449	347,665	356,465	284,673	359,516	274,829	286,357	309,830
23-Jun	72,510	145,583	154,294	345,206	331,480	355,193	362,378	288,042	367,526	284,940	294,056	315,680
24-Jun	75,126	147,460	159,511	349,857	337,809	361,202	369,119	290,992	374,494	300,648	299,638	319,607
25-Jun	77,256	150,473	164,615	353,255	342,712	366,428	375,622	292,577	380,225	317,165	305,235	322,603
26-Jun	79,027	152,446	168,210	355,667	347,128	372,066	380,007	294,958	385,635	329,665	311,613	326,029
27-Jun	81,205	153,761	171,631	358,174	349,860	376,804	387,231	297,993	390,788	336,675	318,172	329,269
28-Jun	82,308	155,458	175,955	361,123	352,034	381,575	393,959	300,257	395,810	342,319	324,431	335,571
29-Jun	83,912	156,908	179,800	364,544	354,164	385,879	398,412	302,404	399,388	349,155	332,651	342,061
30-Jun	85,544	158,807	183,265	366,922	356,477	392,025	404,861	304,543	403,159	353,791	339,148	349,415

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Date	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
01-Jul	87,131	161,458	186,824	369,645	358,667	398,131	413,087	307,163	406,743	355,803	344,750	357,345
02-Jul	89,664	163,982	190,189	372,251	363,087	404,244	420,641	309,771	409,895	359,209	349,430	362,641
03-Jul	92,191	166,841	194,293	374,799	368,838	410,270	429,222	311,590	412,206	363,305	353,652	367,617
04-Jul	95,171	170,647	197,227	378,893	374,083	417,213	435,737	315,126	414,011	370,405	357,184	374,986
05-Jul	97,440	173,655	200,106	383,149	379,078	422,560	442,399	318,380	415,510	374,756	360,488	385,725
06-Jul	99,063	175,651	203,131	386,625	385,378	426,533	447,848	323,044	418,319	378,149	363,998	395,749
07-Jul	100,215	176,543	206,422	390,488	391,549	430,742	451,888	326,671	421,310	383,766	368,322	405,985
08-Jul	101,046	178,634	209,417	394,262	395,539	434,822	455,794	330,564	424,170	390,382	376,821	417,098
09-Jul	101,993	181,824	212,234	397,711	397,749	438,175	459,004	337,391	427,247	396,734	381,988	427,859
10-Jul	103,245	186,033	215,876	400,653	399,819	441,819	461,931	347,998	432,682	405,319	388,335	437,365
11-Jul	104,086	189,717	221,639	402,924	401,799	446,273	465,539	353,455	437,797	410,641	395,955	445,818
12-Jul	104,427	192,979	226,427	406,392	405,219	450,814	469,819	359,784	442,839	416,398	403,836	457,771
13-Jul	104,594	196,123	228,152	408,657	409,251	455,357	474,401	365,036	446,535	422,981	410,923	467,100
14-Jul	104,884	200,247	229,831	411,253	413,590	461,176	480,974	371,149	450,065	429,420	417,935	477,370
15-Jul	105,159	203,782	231,574	414,944	418,304	467,672	486,495	376,173	454,764	435,142	424,859	489,653
16-Jul	105,697	208,957	234,089	417,524	421,865	474,642	493,250	381,512	456,991	441,401	430,316	500,550
17-Jul	106,001	212,512	237,508	418,304	424,790	480,969	498,205	387,472	461,099	445,868	435,193	509,453
18-Jul	106,285	216,272	243,386	426,937	428,203	485,295	502,941	392,582	466,092	450,488	439,050	521,264
19-Jul	106,606	219,616	248,999	447,912	432,499	488,998	506,081	397,142	472,158	454,615	443,633	531,831
20-Jul	106,844	222,332	254,059	468,423	436,419	492,986	509,470	405,318	478,155	458,249	448,116	542,000
21-Jul	106,925	224,915	257,885	484,164	440,468	497,449	512,674	409,446	482,901	460,690	452,080	550,639
22-Jul	106,943	226,927	261,058	490,730	444,339	502,330	516,454	412,604	486,309	461,963	454,877	559,547
23-Jul	106,958	228,842	263,201	496,517	447,438	505,933	519,659	415,474	489,218	462,965	458,306	567,650
24-Jul	106,998	231,024	264,554	501,580	450,499	509,836	521,857	417,636	491,851	463,590	462,206	573,900
25-Jul	107,011	232,136	266,177	504,971	453,873	514,371	523,794	420,085	494,143	465,604	466,229	579,203
26-Jul		232,907	267,433	507,464	456,469	518,210	525,481	422,059	495,942	465,972	470,371	584,909
27-Jul		233,225	268,631	509,915	458,716	521,897	526,872	424,250	497,568	466,598	474,291	590,608
28-Jul		233,612	269,329	512,700	461,091	527,131	527,876	427,089	499,365	469,092	477,743	595,534
29-Jul		233,977	269,729	516,386	462,517	531,269	528,767	429,902	500,928	471,433	481,219	599,684
30-Jul		234,468	270,199	520,200	463,480	534,781	529,705	432,692	502,417	473,508	483,642	602,203
31-Jul		235,171	270,552	524,002	464,656	536,616	530,798	434,540	503,676	475,734	485,562	603,754
01-Aug		235,929	271,377	527,398	465,167	538,528	531,845	435,610	504,848	478,460	487,000	606,053
02-Aug		236,308	272,411	529,702	466,109	540,739	532,933	436,313	505,893	479,759	488,098	607,797
03-Aug		236,535	273,175	531,615	466,603	542,827	534,146		506,663	481,461		
04-Aug		236,821	273,883	532,912	467,184	545,724	535,264		507,477	482,960		
05-Aug		236,994	274,641	534,093	467,306		536,273		507,912	483,478		
06-Aug		237,097	275,518	535,263			536,806		508,328			
07-Aug		237,173	276,133						508,520			
08-Aug			276,299						508,553			
09-Aug			276,538						508,600			

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Date	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Average
15-May						491					
16-May						959		64			
17-May					448	1,491		152			1,195
18-May					1,134	2,013	84	288	158		2,919
19-May					2,086	3,344	156	456	412		4,961
20-May				9,503	3,041	6,372	286	942	585		7,729
21-May	1,121	1,087		23,180	4,651	9,876	624	1,406	2,062		10,548
22-May	5,964	2,804		45,886	7,073	12,684	1,647	3,148	3,339		14,568
23-May	13,141	5,965		74,311	10,631	16,985	3,413	5,892	4,666	960	19,554
24-May	25,064	8,430		106,291	13,528	19,458	4,743	18,088	8,248	1,440	26,216
25-May	39,397	11,476		144,872	17,611	21,299	6,106	45,011	14,099	2,040	33,962
26-May	50,734	14,750		168,519	20,893	24,331	8,298	72,400	19,707	2,412	40,728
27-May	62,794	18,643	1,226	181,404	23,748	28,137	13,088	104,378	28,718	3,271	48,501
28-May	70,228	22,032	2,657	198,880	26,795	35,305	25,944	150,560	38,993	4,400	58,868
29-May	79,404	25,965	5,019	212,036	29,683	45,183	37,952	197,099	50,219	6,857	67,623
30-May	88,945	30,382	10,755	220,514	31,649	57,962	48,813	234,653	68,661	13,051	76,559
31-May	99,288	39,744	18,686	237,200	36,265	68,717	68,807	280,850	91,679	16,661	88,404
01-Jun	109,314	56,577	25,296	253,673	45,688	77,697	94,337	312,407	112,991	18,861	100,257
02-Jun	119,223	77,728	33,215	276,504	53,455	87,125	120,314	343,151	137,197	20,825	113,423
03-Jun	127,799	95,536	44,750	291,095	56,592	92,772	147,579	361,229	162,921	23,291	125,273
04-Jun	135,371	110,093	52,671	308,680	62,735	99,517	169,810	378,791	188,451	25,853	137,789
05-Jun	145,544	128,766	61,966	334,459	68,000	105,412	187,819	394,979	207,515	28,688	151,109
06-Jun	155,954	140,454	76,518	360,102	80,100	114,648	199,129	414,964	221,645	30,515	163,573
07-Jun	167,091	148,894	93,252	378,170	96,832	122,692	215,872	437,576	240,246	36,974	176,522
08-Jun	174,728	158,365	110,981	398,932	114,854	128,430	242,457	471,545	253,965	44,244	191,534
09-Jun	184,633	170,030	131,700	423,929	132,896	133,909	278,141	508,623	261,290	53,514	206,920
10-Jun	196,293	178,595	155,130	443,723	150,484	141,963	309,933	542,803	271,784	68,367	221,692
11-Jun	212,474	186,699	173,721	454,842	162,756	153,913	339,018	573,744	290,255	95,430	236,221
12-Jun	236,403	199,387	187,817	473,164	175,764	161,187	374,655	592,863	307,936	121,915	250,176
13-Jun	260,851	208,453	206,074	486,036	184,845	170,132	401,691	606,227	329,654	146,787	262,281
14-Jun	275,153	217,689	226,530	494,393	200,484	184,153	416,649	622,307	357,935	166,409	274,043
15-Jun	283,543	232,656	250,487	507,744	212,163	196,006	432,197	645,527	378,804	183,605	286,018
16-Jun	293,655	247,023	264,401	521,991	226,390	215,738	446,006	662,516	396,065	202,407	297,293
17-Jun	306,350	257,152	278,910	529,612	237,835	235,656	456,304	684,317	416,826	218,428	308,164
18-Jun	314,402	268,203	293,803	534,533	255,058	253,594	463,663	706,409	435,361	229,088	317,732
19-Jun	324,165	281,124	306,127	540,857	274,450	269,619	478,966	719,120	446,979	242,095	326,407
20-Jun	333,480	295,270	325,607	545,757	285,948	286,482	491,037	726,964	458,479	256,791	334,721
21-Jun	343,772	304,020	342,489	549,293	297,647	301,912	498,607	735,353	470,755	270,893	342,246
22-Jun	353,929	311,850	351,941	552,157	310,952	311,774	509,458	752,906	481,543	285,638	350,065
23-Jun	364,095	318,208	359,175	557,226	329,638	317,094	525,002	760,611	492,450	295,906	357,644
24-Jun	373,435	324,171	365,494	563,297	353,920	324,451	535,228	765,921	505,971	312,821	365,548
25-Jun	383,445	331,831	372,169	567,618	368,060	333,662	543,191	771,381	518,972	326,861	372,601
26-Jun	390,257	341,331	379,349	570,336	380,264	343,651	551,859	779,366	530,189	342,012	379,225
27-Jun	399,491	351,686	385,615	573,706	394,410	359,676	562,114	791,377	540,911	362,557	386,590
28-Jun	406,372	362,496	393,699	578,067	403,623	373,349	571,309	801,804	553,733	377,524	393,393
29-Jun	410,871	372,935	402,957	583,043	419,482	383,072	583,930	812,213	569,584	392,365	400,528
30-Jun	414,846	382,048	410,373	591,427	430,327	387,474	597,021	825,954	584,265	406,871	407,293

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Appendix 2. (page 4 of 4)

Date	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Average
01-Jul	419,169	389,351	417,493	599,066	440,686	393,204	612,508	838,678	597,911	422,938	414,074
02-Jul	424,236	394,460	423,084	604,786	450,488	398,422	625,574	852,244	609,343	433,882	420,155
03-Jul	428,918	400,795	427,725	609,931	460,453	403,273	638,523	867,674	620,379	446,895	426,421
04-Jul	434,583	407,475	433,138	615,458	469,235	407,564	651,479	882,292	628,928	457,101	432,719
05-Jul	442,581	413,320	437,562	621,797	475,431	415,351	660,308	895,740	638,553	466,317	438,731
06-Jul	450,330	419,533	444,549	628,228	484,975	423,523	669,126	906,764	647,310	473,181	444,677
07-Jul	456,030	425,755	451,910	637,457	494,896	430,143	678,133	918,298	657,328	479,877	450,709
08-Jul	461,222	432,824	457,668	647,843	502,843	434,415	686,557	932,034	666,678	496,217	457,215
09-Jul	466,375	439,277	469,605	658,948	512,234	441,260	694,359	939,911	677,985	510,594	463,742
10-Jul	472,995	443,887	478,744	668,514	526,773	456,106	704,151	953,668	691,547	526,193	471,615
11-Jul	478,397	448,364	487,124	675,878	540,429	465,474	714,759	970,366	709,329	543,312	479,134
12-Jul	487,735	453,182	495,083	682,697	556,652	471,941	726,564	980,525	726,990	556,361	486,651
13-Jul	499,167	457,151	501,824	688,312	570,576	477,919	737,393	989,774	743,069	566,603	493,308
14-Jul	507,373	464,649	510,398	695,985	583,909	487,521	747,352	1,002,682	751,332	583,324	500,650
15-Jul	515,682	472,199	519,369	702,097	594,070	499,108	756,817	1,018,433	762,214	600,873	508,239
16-Jul	521,775	481,870	527,052	708,977	602,025	505,043	768,128	1,032,389	771,398	619,105	515,292
17-Jul	528,034	491,538	533,770	714,152	609,667	515,901	779,714	1,047,500	778,776	635,746	522,002
18-Jul	533,760	498,878	542,577	719,550	616,730	526,543	786,948	1,057,364	785,359	647,170	528,434
19-Jul	539,735	506,391	551,192	726,332	621,405	534,707	793,321	1,068,632	791,542	662,465	535,349
20-Jul	544,050	517,072	558,294	733,749	625,327	541,710	798,930	1,080,006	798,476	678,542	542,291
21-Jul	546,584	527,340	563,192	741,593	633,083	547,064	806,369	1,089,982	806,266	694,940	548,569
22-Jul	549,041	537,042	567,804	750,834	646,559	551,660	813,651	1,096,731	813,613	703,467	553,925
23-Jul	552,942	546,059	573,230	764,846	661,006	555,916	820,385	1,103,768	819,566	722,685	559,747
24-Jul	555,825	550,304	577,051	777,569	671,430	560,171	829,268	1,108,979	824,334	739,182	564,615
25-Jul	557,875	553,370	580,035	786,617	684,473	563,481	838,388	1,112,572	829,700	755,763	569,170
26-Jul	560,132	557,792	583,447	793,023	690,370	566,671	845,924	1,116,050	833,506	769,951	573,038
27-Jul	563,017	561,676	587,066	800,488	695,258	571,867	850,758	1,120,320	837,018	778,572	576,587
28-Jul	564,951	566,469	590,271	806,460	700,725	576,960	859,318	1,124,809	841,448	788,221	580,472
29-Jul	567,759	571,823	594,225	812,576	704,721	582,933	866,707	1,128,127	845,291	798,712	584,210
30-Jul	570,221	576,534	598,097	819,079	707,877	589,214	872,188	1,131,381	850,490	811,925	587,810
31-Jul	572,771	579,435	601,952	824,618	711,563	594,253	876,103	1,133,960	855,300	819,899	590,697
01-Aug	576,610			829,178	715,577	597,678	880,168	1,138,356	858,489	832,938	593,733
02-Aug	581,859			833,387		599,267	884,421	1,143,065	861,979	843,469	596,392
03-Aug							888,804	1,148,079	864,953	850,951	598,811
04-Aug							893,886		866,957		600,440
05-Aug							900,815				601,830
06-Aug							906,239				603,251
07-Aug											603,545
08-Aug											603,645
09-Aug											603,788

Appendix 3. Daily water levels, in meters above sea level, at Mile 49 Bridge, Copper River, 1983 - 1999.

Elevation Above Sea Level

Date	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	1983-98 Average
11-May												39.03						
12-May																		
13-May												39.12				39.32		
14-May												39.18				38.74		
15-May					38.99		40.05					39.26	40.71	40.33	39.65			39.83
16-May							40.04					39.33		40.07	39.65	38.76		39.57
17-May					39.09		40.01					39.43		39.77	39.49	38.80		39.43
18-May				39.19	39.10		40.01					39.53	40.27	39.60	39.44	38.85		39.50
19-May				39.31	39.05	39.70	40.06					39.76	40.09	39.57	39.35	39.00		39.54
20-May		39.05		38.97	39.05	39.62	40.07				41.12	40.17	39.65	39.60	39.28	39.06		39.60
21-May		39.08		38.95	39.10	39.65	40.02	40.79	39.42		41.26	40.35	39.87	39.55	39.29	39.08		39.72
22-May		39.31		39.19	39.14	39.65	40.14	40.92	39.52	39.62	41.40	40.19	39.90	39.55	39.62	39.04	39.45	39.80
23-May		39.45		39.29	39.21	39.60	40.23	40.81	39.70	39.68	41.39	40.07	39.98	39.62	40.08	39.09	39.34	39.87
24-May	39.39	39.48		39.37	39.28	39.61	40.27	40.63	39.96		41.38	40.12	40.08	39.75	40.49	39.13	39.35	39.92
25-May	39.39	39.57		39.38	39.29	39.64	40.16	40.48	40.17	39.92	41.54	40.17	40.31	39.85	40.50	39.16	39.43	39.97
26-May	39.36	39.61		39.46	39.36	39.67	40.17	40.48	40.33	40.10	41.68	40.05	40.71	39.87	40.40	39.28	39.44	40.04
27-May	39.37	39.71		39.54	39.46	39.75	40.27	40.58	40.41	40.30	41.67	40.03	41.06	39.89	40.27	39.58	39.46	40.13
28-May	39.39	39.75	40.28	39.60	39.46	39.78	40.42	40.77	40.51	40.55	41.65	40.11	41.04	39.95	40.22	39.91	39.44	40.21
29-May	39.38	39.61	40.34	39.77	39.48	39.82	40.60	41.00	40.55	40.73	41.77	40.08	41.04	39.98	40.22	40.26	39.53	40.29
30-May	39.44	39.55	40.31	39.97	39.45	39.87	41.00	41.47	40.56	40.94	41.93	40.22	40.88	40.11	40.40	40.64	39.54	40.42
31-May	39.58	39.47	40.18	39.96	39.48	40.00	41.49	41.72	40.58	40.97	42.11	40.23	40.69	40.29	40.42	41.09	39.42	40.52
01-Jun	39.94	39.46	40.03	39.97	39.76	40.12	41.82	41.00	40.51	41.13	42.35	40.21	40.54	40.51	40.40	41.27	39.37	40.56
02-Jun	40.64	39.42	39.90	39.96	39.98	40.14	41.87	42.03	40.42	41.22	42.37	40.22	40.45	40.96	40.45	41.25	39.55	40.70
03-Jun	41.00	39.39	39.88	39.97	40.33	40.16	41.70	42.18	40.32	41.34	42.40	40.27	40.37	41.08	40.45	41.21	39.55	40.75
04-Jun	40.94	39.45	39.95	39.90	40.36	40.26	41.70	42.26	40.31	41.50	42.49	40.30	40.26	41.18	40.37	41.42	39.56	40.79
05-Jun	40.94	39.61	40.18	39.88	40.30	40.32	42.02	42.45	40.38	41.56	42.53	40.40	40.22	41.22	40.57	41.45	39.65	40.88
06-Jun	40.89	39.75	40.44	39.98	40.43	40.35	42.11	42.67	40.42	41.52	42.60	40.52	40.22	41.08	41.06	41.55	39.87	40.97
07-Jun	40.82	40.04	40.36	40.19	40.73	40.61	42.06	42.81	40.47	41.38	42.74	40.75	40.29	40.90	41.42	41.54	40.13	41.07
08-Jun	40.82	40.34	40.11	40.43	40.88	40.82	42.00	42.98	40.55	41.53	42.68	40.88	40.45	40.97	41.49	41.96	40.52	41.18
09-Jun	40.85	40.36	40.03	40.46	40.69	41.15	41.89	42.96	40.60	41.62	42.35	40.97	40.63	41.08	41.45	42.50	40.84	41.23
10-Jun	40.84	40.36	40.06	40.36	40.64	41.48	41.92	42.85	40.58	41.73	42.03	41.10	40.81	41.03	41.45	42.86	41.16	41.26
11-Jun	40.82	40.43	40.01	40.24	40.54	41.80	41.80	42.63	40.71	41.91	41.84	41.38	41.35	40.88	41.46	42.63	41.37	41.28
12-Jun	40.84	40.56	40.01	40.13	40.38	42.00	41.65	42.47	40.87	42.17	41.84	41.55	42.09	40.70	41.44	42.25	41.45	41.31
13-Jun	40.81	40.68	40.11	40.22	40.34	42.19	41.73	42.44	41.06	42.48	41.86	41.74	42.71	40.54	41.45	41.89	41.64	41.39
14-Jun	40.67	40.84	40.13	40.33	40.37	42.36	41.78	42.61	41.31	42.74	41.94	42.00	43.04	40.51	41.51	41.71	41.96	41.49
15-Jun	40.71	40.97	40.16	40.62	40.36	42.45	42.03	42.66	41.53	42.89	42.08	42.44	43.22	40.47	41.51	41.65	42.19	41.61
16-Jun	40.60	41.07	40.13	41.05	40.36	42.64	42.13	42.58	41.77	43.01	42.35	42.82	43.33	40.43	41.49	41.72	42.35	41.72
17-Jun	40.75	41.05	40.13	41.58	40.44	42.80	42.02	42.52	42.00	42.97	42.58	43.11	43.09	40.50	41.48	41.82	42.50	41.80
18-Jun	40.88	40.89	40.36	41.83	40.57	42.99	41.94	42.39	42.10	42.85	42.61	43.26	42.67	40.72	41.41	41.96	42.66	41.84
19-Jun	40.97	40.97	40.49	41.88	40.51	42.90	42.02	42.15	42.04	42.63	42.57	43.25	42.62	40.97	41.52	42.08	42.83	41.85
20-Jun	41.31	41.15	40.49	41.89	40.43	42.56	42.09	42.03	42.05	42.47	42.60	43.02	42.65	41.14	41.69	42.24	42.73	41.86
21-Jun	41.58	41.31	40.51	41.71	40.36	42.32	42.15	41.91	42.53	42.58	42.46	42.89	42.68	41.35	41.67	42.21	42.62	41.89
22-Jun	41.85	41.66	40.34	41.54	40.70	42.53	42.22	41.92	43.14	42.91	42.50	42.72	42.65	41.48	41.73	42.25	42.42	42.01
23-Jun	41.95	41.76	40.39	41.43	41.18	42.25	42.34	41.93	43.69	42.99	42.52	42.85	42.67	41.70	42.03	42.27	42.26	42.12
24-Jun	42.01	41.99	40.46	41.29	41.27	41.82	42.48	42.01	44.02	42.90	42.58	43.16	42.85	42.03	42.43	42.19	42.12	42.22
25-Jun	42.19	42.35	40.74	41.11	41.23	41.73	42.84	42.02	44.03	42.66	42.64	43.34	42.60	42.28	42.72	42.12	42.07	42.29
26-Jun	42.43	42.60	40.79	41.00	41.10	41.68	43.13	42.09	43.83	42.42	43.00	43.39	42.22	42.43	42.99	42.24	42.20	42.33
27-Jun	42.44	42.75	40.77	40.97	40.98	41.68	43.11	42.31	43.64	42.26	42.75	43.06	42.35	42.43	43.28	42.37	42.37	42.32
28-Jun	42.43	42.58	40.97	41.17	41.28	41.55	43.01	42.59	43.57	42.44	42.61	42.54	42.11	42.25	43.28	42.38	42.32	42.30
29-Jun	42.60	42.37	41.20	41.52	41.00	41.79	42.98	42.96	43.66	42.68	42.57	42.20	42.20	41.82	43.66	42.40	42.27	42.35
30-Jun	42.55	42.14	41.43	41.62	41.53	41.79	43.03	43.27	43.78	42.99	42.60	42.05	42.35	41.51	43.71	42.46	42.34	42.42

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Appendix 3. (page 2 of 2).

Elevation Above Sea Level

Date	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	1983-98 Average
01-Jul	42.43	41.88	41.86	41.96	42.37	41.73	43.10	43.49	43.87	43.28	42.65	42.08	42.53	41.43	43.75	42.65	42.38	42.57
02-Jul	42.24	41.94	42.32	42.37	42.83	41.82	43.31	43.78	43.90	43.61	42.61	42.34	42.76	41.44	43.71	42.90	42.47	42.74
03-Jul	42.33	41.91	42.55	42.61	42.85	41.99	43.49	43.76	43.77	44.15	42.62	42.47	42.98	41.56	43.70	43.16	42.59	42.87
04-Jul	42.51	41.91	42.62	42.70	42.91	42.29	43.41	43.71	43.76	44.35	42.55	42.48	43.16	41.71	43.65	43.36	42.87	42.94
05-Jul	42.60	41.96	42.62	42.85	43.04	42.51	43.43	43.71	43.53	44.53	42.63	42.55	43.23	41.90	43.71	43.44	43.10	43.01
06-Jul	42.67	41.86	42.67	43.03	43.16	42.66	43.38	43.74	43.24	44.55	42.59	42.55	43.40	41.95	43.76	43.48	43.19	43.04
07-Jul	42.70	42.06	42.85	43.11	43.12	42.95	43.42	43.85	43.07	44.38	42.53	42.44	43.60	41.99	43.71	43.47	43.09	43.08
08-Jul	42.84	42.29	42.93	43.13	42.93	43.08	43.43	43.75	43.08	44.19	42.34	42.23	43.75	42.11	43.72	43.31	43.00	43.07
09-Jul	42.81	42.52	42.75	43.03	42.33	43.06	43.50	43.51	43.22	43.71	42.08	42.24	43.71	42.21	43.46	42.87	42.95	42.94
10-Jul	42.82	42.72	42.55	42.70	42.52	42.94	43.63	43.14	43.49	43.39	42.50	42.38	43.58	42.28	43.22	42.53	42.85	42.90
11-Jul	42.72	42.62	42.52	42.62	42.49	42.72	43.74	42.81	43.22	43.34	42.82	42.34	43.53	42.24	43.18	42.43	42.73	42.83
12-Jul	42.55	42.47	42.55	42.76	42.50	42.53	43.95	42.58	43.04	43.48	43.07	42.43	43.61	42.03	43.24	42.63	42.78	42.84
13-Jul	42.14	42.32	42.62	42.80	42.53	42.72	44.07	42.51	42.94	43.72	43.16	42.52	43.51	41.98	43.17	42.62	42.85	42.83
14-Jul	41.98	42.19	42.60	42.78	42.41	42.73	44.03	42.42	42.92	43.65	43.45	42.63	43.40	42.02	43.14	42.58	42.86	42.81
15-Jul	41.80	42.16	42.55	42.51	42.47	42.66	43.82	42.37	42.85	43.42	43.61	42.78	43.35	42.11	43.11	42.65	42.78	42.76
16-Jul	41.95	42.06	42.44	42.35	42.43	42.64	43.51	42.28	42.82	43.41	43.76	42.98	43.30	42.01	43.05	42.60	43.07	42.72
17-Jul	42.10	41.96	42.42		42.47	42.72	43.20	42.12	42.96	43.27	44.04	42.99	43.01	41.91	43.04	42.66	43.41	42.73
18-Jul	42.23	41.83	42.49		42.35	43.03	43.14	42.50	42.86	43.19	44.14	42.97	43.01	42.10	42.97	42.61	43.43	42.76
19-Jul	42.46	41.96	42.49		42.36	43.18	43.30	42.78	42.50	43.16	44.07	43.06	43.12	42.30	42.93	42.51	43.29	42.81
20-Jul	42.55	41.99	42.60		42.63	43.18	43.47	43.06	42.17	43.16	43.82	42.68	43.10	42.44	42.90	41.78	42.93	42.77
21-Jul	42.53	41.76	42.90		42.78	43.24	43.58	43.28	42.11	43.31	43.85	42.73	43.17	42.47	42.87	42.33	42.93	42.86
22-Jul	42.48	41.63	42.88	43.53	43.36	43.53	43.32	43.57	42.27	43.34	43.87	42.44	43.32	42.53	42.65	42.44	42.96	42.95
23-Jul	42.27	41.61	42.62	43.41	43.51	43.40	43.14	43.62	42.41	43.14	43.44	42.21	43.59	42.53	42.66	42.42	42.96	42.87
24-Jul	42.30	41.66	42.37	43.34	43.39	43.38	43.00	43.72	42.70	42.92	43.29	42.13	43.74	42.46	42.66	42.33	42.52	42.84
25-Jul	42.30	41.86	42.24		43.17	43.04	42.91	43.83	42.87	42.84	43.19	42.26	43.42	42.56	42.75	42.17	42.29	42.76
26-Jul	42.20	42.06	42.24	42.77	43.01	42.70	42.86	43.75	42.97	43.11	43.21	42.40	43.16	42.67	42.85	42.28	42.13	42.77
27-Jul	42.10	42.19	41.99	42.45	43.02	42.54	42.81	43.25	42.95	43.26	43.29	42.68	42.89	42.65	42.85	42.36	42.13	42.71
28-Jul	42.23	42.29	41.99	42.22	43.16	42.58	42.75	42.90	42.90	43.18	43.33	42.76	42.72	42.65	43.28	42.31	42.34	42.70
29-Jul	42.51	42.29	42.11	42.01	43.23	42.58	42.87	43.15	42.82	42.99	43.43	42.83	42.38	42.75	43.63	42.18	42.50	42.74
30-Jul	42.68	42.39	42.24	41.94	43.29	42.43	42.96	43.46	42.77	42.88	43.49	42.94	42.31	42.88	43.80	42.18	42.59	42.79
31-Jul	42.76	42.34	42.39	41.98	43.26	42.38	43.13	43.51	42.65	42.81	43.53	43.28	42.33	43.21	43.81	42.15	42.41	42.85
01-Aug	42.79	42.39	42.55		43.07	42.31	43.29	43.51			43.60	42.96	42.33	43.13	43.65	42.28	42.48	42.91
02-Aug	42.66	42.32	42.98		42.98	42.33	43.37	43.51			43.40	43.17	42.33	42.92	43.45	42.35	42.70	42.91
03-Aug	42.61	42.34	44.35		42.92	42.48						43.52		42.51	43.34	42.38	43.17	42.94
04-Aug	42.55	42.34	45.09		42.93	42.81								42.35		42.16	43.46	42.89
05-Aug	42.62	42.42			42.88									42.29				42.55
06-Aug		42.42												42.11				42.26
07-Aug		42.42												41.91				42.16
08-Aug		42.42																42.42